

<b>REPORT DOCUMENTATION PAGE</b>				<i>Form Approved</i> <i>OMB No. 0704-0188</i>	
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<b>1. REPORT DATE (DD-MM-YYYY)</b> 31 Mar 2015		<b>2. REPORT TYPE</b> Consultative Letter		<b>3. DATES COVERED (From – To)</b> July 2014 – December 2014	
<b>4. TITLE AND SUBTITLE</b>  Consolidated Site (CS) 022 Verification Survey at Former McClellan AFB, Sacramento, California				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Matthew W. Uelen				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> USAF School of Aerospace Medicine Occupational & Environmental Health Dept Consultative Services Division 2510 Fifth St. Wright-Patterson AFB, OH 45433-7913				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFRL-SA-WP-CL-2015-0011	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSORING/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b>  Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW-2015-1640, 31 Mar 2015					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), Radiation Health Consulting Branch performed an independent radiological verification survey of the CS 022 hazardous waste site, located on former McClellan AFB, California, on 29-31 July 2014. The purpose of this verification survey was to provide an independent evaluation of the final radiological conditions. USAFSAM/OEC surveyed the CS 022 site to measure residual surface activity and determine if radiation levels complied with criteria agreed upon between representatives of the State of California and the U.S. Air Force for unrestricted release. Radium-226 was the sole radionuclide of concern. Cabrera Services, Inc., under contract with URS Corporation, performed a Final Status Survey (FSS) and all radiological fieldwork previously in July 2014. This letter details the findings of this visit and will assist the RICS with evaluating the contractor's FSS report of this site					
<b>15. SUBJECT TERMS</b> USAF School of Aerospace Medicine (USAFSAM), former McClellan AFB, radium-226, verification survey, final status survey, independent radiological assessment					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>  SAR	<b>18. NUMBER OF PAGES</b>  39	<b>19a. NAME OF RESPONSIBLE PERSON</b> Col Krystal L. Murphy
<b>a. REPORT</b> U	<b>b. ABSTRACT</b> U	<b>c. THIS PAGE</b> U			<b>19b. TELEPHONE NUMBER (include area code)</b>



**DEPARTMENT OF THE AIR FORCE**  
**USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)**  
**WRIGHT-PATTERSON AFB OH**

31 March 2015

MEMORANDUM FOR AFMSA/SG3PB  
ATTN: MAJ DANIEL SHAW  
USAF RADIOISOTOPE COMMITTEE SECRETARIAT  
AIR FORCE MEDICAL SUPPORT AGENCY  
7700 ARLINGTON BOULEVARD, SUITE 5158  
FALLS CHURCH VA 22042-5158

FROM: USAFSAM/OEC  
2510 Fifth Street  
Wright-Patterson AFB OH 45433-7913

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2015-0011, Consolidated Site (CS) 022  
Verification Survey at Former McClellan AFB, Sacramento, California

1. INTRODUCTION:

a. *Purpose:* At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), Radiation Health Consulting Branch performed an independent radiological verification survey of the CS 022 hazardous waste site, located on former McClellan AFB, California, on 29-31 July 2014. The purpose of this verification survey was to provide an independent evaluation of the final radiological conditions at a decommissioned site. USAFSAM/OEC surveyed the CS 022 site to measure residual surface activity and determine if radiation levels complied with criteria agreed upon between representatives of the State of California and the U.S. Air Force for unrestricted release. Radium-226 (Ra-226) was the sole radionuclide of concern. Cabrera Services, Inc., under contract with URS Corporation, performed a Final Status Survey (FSS) and all radiological fieldwork previously in July 2014. This letter details the findings of this visit and will assist the RICS with evaluating the contractor's FSS report of this site. Personnel utilized techniques and procedures taken from Nuclear Regulatory Guide 1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Rev 1.

b. *Background:* Site CS 022 is a former burial pit, 1 acre in size, located within the west McClellan District. Historical site information provided by URS Corporation indicated that between 1946 and the late 1960s the site was used as a burial pit for industrial waste, solvents, and ash from an industrial incinerator located near the site. Documentation from the contractor indicates that ash and waste from the incinerator are the primary source of Ra-226 contamination. During the 1990s, the site was enclosed with a fence and used as a storage yard for building materials, construction debris, sand, and gravel. The contractor opted to divide the CS 022 site into two separate survey unit areas. The first survey unit consists of two distinct trenched areas, the largest of which runs east to west along the northern area of the site. At the deepest point, the trench is approximately 50 feet below ground level. An intersecting trench, running north to south, is shallower and slopes into the first. The second survey unit contains surface contamination and surrounds the trench running north to south. This area is approximately 1 to 2 feet below ground level. This report includes a discussion and conclusion on only the first survey unit, as this was the only unit that had undergone an FSS at the time of this survey. See Figures 1 and 2 below.



**Figure 1. CS 022 North/South Disposal Trench**



**Figure 2. CS 022 East/West Disposal Trench**

*c. Survey Personnel:*

- (1) Maj. Marcus Grant, Health Physicist, USAFSAM/OEC
- (2) SSgt Michael Ames, Lead Health Physics Technician, USAFSAM/OEC

*d. Personnel Contacted:*

- (1) Radiation Safety Officer, AFCEC/CIBW
- (2) Base Realignment and Closure Program Management/Western Region, AFCEC/CIBW
- (3) Radiation Project Manager, Cabrera Services, Inc.

*e. Equipment:* Ludlum Model 2221 with Scionix 76BRS76/2ME1-X 3x3 Sodium Iodide Detector, Meter SN 287511, Detector SN SAG420, Calibration date 16 Jun 2014

## 2. METHODOLOGY:

a. *Overview:* The verification survey consisted of soil sample collection and gamma walkover measurements. The goal of the walkover survey was to identify locations for soil sampling. This verification survey required scanning at least 10% of the trench floor area by the gamma walkover technique and soil sample collection of at least 10% of the total number of samples taken by Cabrera Services. Prior to the survey, the contractor identified 68 soil sampling locations from both survey units; therefore, at least 7 soil samples are necessary to meet the 10% minimum requirement. It should be noted that this requirement includes the survey unit not included in this report; therefore, the actual quantity needed is less than 7. Personnel used the gamma walkover data to qualitatively assess the site in terms of mean count rate and standard deviation. Minimum detectable concentration and the associated count rates were not calculated.

b. *Soil Sampling*: Each sample was taken from an area of approximately 8 square inches to a depth of 6 inches. The volume sampled was sufficient for laboratory analysis (approximately 1 quart). Survey personnel followed field soil sampling procedures to prevent cross contamination of samples. Personnel collected a background sample from uncontaminated soil in an adjacent area to the CS 022 site. The USAFSAM Radioanalytical Laboratory (OEA) at Wright-Patterson AFB, Ohio, analyzed soil samples by counting on a high purity germanium detector, using the appropriate in-growth method to determine Ra-226 levels in soil. Prior to the 28-day in-growth, OEA sifted the soil samples to remove any rocks and large debris and then dried to remove any moisture potentially affecting analysis. Attachment 1 contains laboratory analysis for the samples. An “x” within Attachment 2 indicates the locations of soil samples.

c. *Gamma Walkover Survey*: Scionix Model 76BRS76/3M-E1-X 3x3-inch thallium-doped sodium iodide (NaI) detectors and Ludlum Model 2221 ratemeter/scalers were the primary radiation detection instruments utilized to perform the gamma walkover survey. Survey personnel connected the instruments to a Trimble GeoXT handheld GPS unit via RS-232 serial cable. The Trimble GeoXT logged observed count rates with corresponding GPS coordinates every second. Survey personnel held the detectors at a height of 10 cm above the ground. The scan speed was approximately 0.5 meters per second, while scan lines were spaced approximately 0.5 meters apart. All field instruments were function checked at the start and end of each workday using a gamma-emitting check source. Personnel tested each instrument to ensure a 10% tolerance during field checks. Qualified staff calibrate the instruments annually. Attachment 3 contains the annual calibration certificates for all instruments used during this survey. Attachment 4 contains the quality control logs used to document instrument performance with a check source both before and after use.

### 3. RESULTS:

a. *Gamma Walkover Survey*: Scan coverage exceeded the minimum scan requirement of 10% of the trench floor. Some areas were inaccessible using the walkover technique, notably in areas that presented a climbing hazard. The team did not survey the sides of the trench. Personnel used the mean count rate as the background for the scanned area and did not survey a reference area. USAFSAM personnel calculated the mean and standard deviation of the dataset based on the instrument and the particular area surveyed. In some cases, USAFSAM also excluded data outside the background distribution (e.g., outlying data points, data generated due to software anomalies or equipment malfunctions). Personnel then compiled the data using commercial geospatial mapping software. The locations marked in green correspond to the lowest readings of the survey. Given the data collected, green dots represent all measured activity points below 1.5 standard deviations (SD) above the mean value [less than 26568 counts per minute (cpm)]. Yellow dots correspond to data points between 0.5 and 1.5 SD above the mean (between 26569 and 29972 cpm). Orange dots correspond to data points between 1.5 and 2.5 SD above the mean (between 29973 and 33377 cpm). Red dots represent all data points above 2.5 SD (greater than 33378 cpm). Survey personnel expect higher concentrations in areas not colored in green. The color scheme demonstrates a scale of instrument data based upon standard deviations from background radiation levels, where no regulatory values are implied. A table of statistics compiled from the dataset can be found in Attachment 5.

b. *Soil Sampling*: Survey personnel collected nine soil samples from CS 022: five samples within the survey unit consisting of the two trenched areas, three samples in the survey unit consisting of surface contamination, and one sample outside of CS 022 in an area of soil to be used as backfill for the site. The survey team used this backfill sample for background radiation comparison. None of the samples collected exceeded the cleanup goal of 2.0 pCi/g. Table 1 illustrates both the gross and background subtracted soil results and the associated GPS coordinates for each sample. When comparing results to the cleanup level of 2.0 pCi/g, utilize the gross (background included) results listed below. The uncertainties listed are at the 95% confidence level (2 SD). Laboratory staff determines concentrations of Ra-226 in the soil by gamma spectroscopy analysis of Ra-226 and the associated bismuth-214 / lead-213 daughters in secular equilibrium. The Ra-226 concentrations in the table below are labeled as “Ra\_D\_214” within Attachment 1.

**Table 1. Soil Sample Results for CS 022**

Lab Sample ID	GPS Coordinates (WGS1984, Decimal Degrees, N/E)	Gross Ra-226 Concentration (pCi/g) <sup>1</sup>	Net Ra-226 Concentration above Background (pCi/g)
GS-14-0001	38.656716324, -121.414152299	0.86 ± 0.04	0.15 ± 0.06
GS-14-0002	38.656796516, -121.414370919	0.62 ± 0.03	N/A
GS-14-0003	38.656347516, -121.413607583	0.50 ± 0.03	N/A
GS-14-0004 <sup>2</sup>	38.656486001, -121.413954240	0.70 ± 0.04	N/A
GS-14-0005	38.656653653, -121.413278950	0.77 ± 0.04	0.06 ± 0.06
GS-14-0006	38.656799100, -121.413738387	0.82 ± 0.04	0.11 ± 0.06
GS-14-0007 <sup>2</sup>	38.656192561, -121.413724655	0.68 ± 0.04	N/A
GS-14-0008 <sup>2,3</sup>	38.657050529, -121.413165411	0.71 ± 0.04	N/A <sup>1,2</sup>
GS-14-0009 <sup>2</sup>	38.656401249, -121.413416446	0.72 ± 0.04	0.01 ± 0.06

<sup>1</sup> Ra-226 concentrations with associated uncertainties from soil sample results.

<sup>2</sup> Sample taken outside the disposal pit survey unit.

<sup>3</sup> Background sample for CS 022.

#### 4. DISCUSSION:

a. *Gamma Walkover Survey*: Walkover survey results indicated one area near the western edge of the site to be the most probable location for Ra-226 contamination. This area indicated count rates in excess of 3 SD above the mean, with the highest recorded gamma value of 35,742 cpm, approximately 10,000 cpm above the mean. During this survey, Cabrera field technicians also identified the same area as indicating elevated gamma count values during their walkover survey. Laboratory soil results indicate slightly elevated and detectable levels of various other naturally occurring radioactive materials in this sample, which survey personnel likely detected during the gamma walkover.

b. *Soil Sampling*: As a result of the gamma walkover survey results, one biased soil sample (S1408005-01A) was taken from the area to be most probable for Ra-226 contamination. The remaining four soil samples collected were random (unbiased) samples co-located at sampling locations previously selected by the contractor.

c. An FSS was completed for the survey unit consisting only of the two trenched areas. Since an FSS is still pending for the second survey unit containing surficial contamination, the soil sample results for this area are for informational purposes only.

## 5. CONCLUSIONS AND RECOMMENDATIONS:

a. Based on the results of the laboratory analysis, none of the areas surveyed exceeded the cleanup goal of 2.0 pCi/g. Laboratory analysis is the primary indicator of site conditions for regulatory decisions.

b. USAFSAM/OEC detected no areas of elevated radiological activity requiring additional investigative actions using the gamma walkover technique.

c. USAFSAM/OEC recommends the survey unit consisting of the two trenched areas be considered for unrestricted free release of radiological controls, with the approval of the RICS.

d. Following the completion of the FSS for the second surface contamination survey unit of CS 022, a second independent radiation verification survey should be performed to assess this area. The contractor needs to complete remediation actions.

e. If you have any questions regarding this report, please contact the ESOH Service Center at (888) 232-3764 (DSN 798-3764) or [ESOH.Service.Center@us.af.mil](mailto:ESOH.Service.Center@us.af.mil).



MATTHEW W. UELEN  
USAFSAM Health Physicist

## 5 Attachments:

1. Laboratory Soil Analysis
2. Map of Gamma Walkover with Soil Sample Locations
3. Instrument Calibration Sheets
4. Radiation Meter Quality Control (QC) Log
5. Statistical Summary of Instrument Data

**Attachment 1**  
**Laboratory Soil Analysis**





MEMORANDUM FOR: SSgt Michael Ames  
USAFSAM/OEC  
2510 Fifth St. Bldg. 840  
WRIGHT-PATTERSON AFB, OH 45433

9/10/2014 10:30:43 AM

FROM: USAFSAM OE Industrial Hygiene  
2510 Fifth Street, Bldg 20840, Room W327  
Wright Patterson Air Force Base, OH 45433-7913

REF: Order No.: S1408005

Dear SSgt Michael Ames:

Enclosed are the sample reports from 14 samples received on 8/5/2014.

Samples, not consumed in analysis, will be held according to the appropriate regulatory authority unless you specifically request otherwise. Should you choose to reproduce this report, we recommend you do so in its entirety so that the integrity of the data package is kept intact.

If you have questions, or if we may be of further assistance to you, please do not hesitate to contact us.

Sincerely,

ERIC L WEATHERHOLT, Capt, USAF  
Analytical Services Program Manager  
Tel: (937) 938-2523 (DSN Prefix: 798)  
<https://hpws.afrl.af.mil/dhp/OE/ESOHSC/pages/index.cfm?id=742>

Note: Sample analysis performed by: USAFSAM/OE Radioanalytical Division

This report is intended solely for the purpose of the person to whom it is addressed. If received in error, please notify the Program Manager listed above.

## USAFSAM OE Industrial Hygiene

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CLIENT: USAFSAM/OEC

Project:

### CASE NARRATIVE

Lab Work Order: S1408005

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There were no problems associated with the samples or analysis except where noted below. Unless otherwise noted, sample results are not blank corrected, and all quality control associated with the samples were within acceptable limits.

These results relate only to the items tested.

Customer requested Ra226 analysis via gamma spectrometry. Analysis report will show results for Ra\_D\_214. This result is equivalent to Ra226 plus the ingrowth of Bi214/Pb214 daughters using all higher energy, high yield energy lines. Ra\_D\_214 = Ra226 via gamma spec analysis with ingrowth.

#### *Sample Preparation Comments:*

<i>SampID</i>	<i>TestCode</i>	<i>Comments</i>
S1408005-01A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-02A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-03A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-04A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-05A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-06A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-07A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15



**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140001  
Lab Sample ID: S1408005-01A  
Matrix: Soil  
Collection Date: 7/29/2014  
Receive Date: 8/5/2014  
Collector: Client  
Report Date: 9/10/2014 10:30:43 AM  
Client ID: 0206OC

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G,N	9.07E-02	2.82E-02	2.20E-02	4.48E-02	pCi/g	JRO	09/05/14 1241	7630
TL-208	G,N	3.88E-01	3.46E-02	2.13E-02	4.38E-02	pCi/g	JRO	09/05/14 1241	7630
TH-234	G,N	1.15E+00	8.12E-01	9.62E-01	1.95E+00	pCi/g	JRO	09/05/14 1241	7630
TH-228	G,N	1.68E+00	8.11E-01	1.21E+00	2.47E+00	pCi/g	JRO	09/05/14 1241	7630
PB-212	G,N	1.46E+00	5.98E-02	2.67E-02	5.46E-02	pCi/g	JRO	09/05/14 1241	7630
BI-212	G,N	1.35E+00	3.09E-01	2.20E-01	4.59E-01	pCi/g	JRO	09/05/14 1241	7630
AC-228	G,N	1.26E+00	7.51E-02	7.17E-02	1.49E-01	pCi/g	JRO	09/05/14 1241	7630
RA-224		9.58E-01	2.91E-01	2.67E-01	5.46E-01	pCi/g	JRO	09/05/14 1241	7630
Ra_D_214		8.64E-01	4.41E-02	3.68E-02	7.58E-02	pCi/g	JRO	09/05/14 1241	7630
K-40		1.38E+01	9.03E-01	2.57E-01	5.35E-01	pCi/g	JRO	09/05/14 1241	7630

BRIAN J STROH, Capt, USAF  
Chief, Radioanalytical Laboratory

AURELIE M SOREFAN, DR-II, PhD, DAF  
Technical Director, Radioanalytical Laboratory



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2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140002  
Lab Sample ID: S1408005-02A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/29/2014  
Receive Date: 8/5/2014  
Collector: Client

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<b>Gamma Spec Full</b>									
TL-208	G,N	2.32E-01	2.89E-02	1.93E-02	3.97E-02	pCi/g	JRO	09/05/14 1842	7630
TH-234	G,N	1.94E+00	7.29E-01	9.86E-01	2.00E+00	pCi/g	JRO	09/05/14 1842	7630
PB-212	G,N	8.80E-01	4.41E-02	2.80E-02	5.71E-02	pCi/g	JRO	09/05/14 1842	7630
BI-212	G,N	8.89E-01	2.82E-01	2.23E-01	4.63E-01	pCi/g	JRO	09/05/14 1842	7630
AC-228	G,N	7.29E-01	7.34E-02	6.90E-02	1.43E-01	pCi/g	JRO	09/05/14 1842	7630
RA-224		7.66E-01	2.55E-01	2.90E-01	5.92E-01	pCi/g	JRO	09/05/14 1842	7630
Ra_D_214		6.24E-01	3.47E-02	3.33E-02	6.87E-02	pCi/g	JRO	09/05/14 1842	7630
K-40		2.08E+01	1.17E+00	2.15E-01	4.49E-01	pCi/g	JRO	09/05/14 1842	7630

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Address: 2510 Fifth St Bldg 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140003  
Lab Sample ID: S1408005-03A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
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TH-234	G,N	8.92E-01	7.02E-01	8.91E-01	1.81E+00	pCi/g	JRO	09/06/14 044	7630
PB-212	G,N	8.10E-01	4.21E-02	2.82E-02	5.76E-02	pCi/g	JRO	09/06/14 044	7630
BI-212	G,N	7.30E-01	2.86E-01	2.17E-01	4.52E-01	pCi/g	JRO	09/06/14 044	7630
AC-228	G,N	7.01E-01	6.74E-02	6.85E-02	1.43E-01	pCi/g	JRO	09/06/14 044	7630
RA-224		5.10E-01	2.38E-01	2.81E-01	5.75E-01	pCi/g	JRO	09/06/14 044	7630
Ra_D_214		5.02E-01	3.32E-02	3.71E-02	7.61E-02	pCi/g	JRO	09/06/14 044	7630
K-40		1.94E+01	1.12E+00	2.04E-01	4.29E-01	pCi/g	JRO	09/06/14 044	7630

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TL-208	G, N	2.85E-01	3.02E-02	1.87E-02	3.86E-02	pCi/g	JRO	09/06/14 645	7630
TH-234	G, N	1.20E+00	7.38E-01	8.78E-01	1.79E+00	pCi/g	JRO	09/06/14 645	7630
TH-228	G, N	2.91E+00	7.97E-01	1.09E+00	2.21E+00	pCi/g	JRO	09/06/14 645	7630
PB-212	G, N	9.93E-01	4.96E-02	2.76E-02	5.64E-02	pCi/g	JRO	09/06/14 645	7630
PA-234M	G, N	5.92E+00	4.23E+00	4.31E+00	9.15E+00	pCi/g	JRO	09/06/14 645	7630
BI-212	G, N	8.43E-01	4.66E-01	3.70E-01	7.59E-01	pCi/g	JRO	09/06/14 645	7630
AC-228	G, N	8.85E-01	6.84E-02	6.86E-02	1.43E-01	pCi/g	JRO	09/06/14 645	7630
EU-154	E, N	1.12E-01	8.77E-02	1.11E-01	2.36E-01	pCi/g	JRO	09/06/14 645	7630
CD-109	D, F, N	5.78E-01	2.94E-01	3.70E-01	7.53E-01	pCi/g	JRO	09/06/14 645	7630
RA-224		6.38E-01	2.61E-01	2.68E-01	5.49E-01	pCi/g	JRO	09/06/14 645	7630
Ra_D_214		6.98E-01	3.62E-02	3.10E-02	6.42E-02	pCi/g	JRO	09/06/14 645	7630
K-40		1.39E+01	9.00E-01	2.51E-01	5.21E-01	pCi/g	JRO	09/06/14 645	7630

BRIAN J STROH, Capt, USAF  
Chief, Radioanalytical Laboratory

AURELIE M SOREFAN, DR-II, PhD, DAF  
Technical Director, Radioanalytical Laboratory



**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523  
**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140005  
Lab Sample ID: S1408005-05A  
Matrix: Soil  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client  
Report Date: 9/10/2014 10:30:43 AM  
Client ID: 0206OC

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G,N	1.01E-01	3.45E-02	2.74E-02	5.56E-02	pCi/g	JRO	09/06/14 1247	7630
TL-208	G,N	3.34E-01	4.62E-02	3.83E-02	7.78E-02	pCi/g	JRO	09/06/14 1247	7630
TH-234	G,N	2.36E+00	8.38E-01	9.97E-01	2.03E+00	pCi/g	JRO	09/06/14 1247	7630
TH-228	G,N	2.87E+00	8.53E-01	1.03E+00	2.10E+00	pCi/g	JRO	09/06/14 1247	7630
PB-212	G,N	1.17E+00	5.80E-02	2.84E-02	5.80E-02	pCi/g	JRO	09/06/14 1247	7630
BI-212	G,N	1.18E+00	3.40E-01	2.40E-01	4.99E-01	pCi/g	JRO	09/06/14 1247	7630
AC-228	G,N	1.05E+00	7.18E-02	7.10E-02	1.48E-01	pCi/g	JRO	09/06/14 1247	7630
CD-109	F,N	4.71E-01	5.24E-01	4.20E-01	8.55E-01	pCi/g	JRO	09/06/14 1247	7630
RA-224		6.38E-01	2.83E-01	2.99E-01	6.13E-01	pCi/g	JRO	09/06/14 1247	7630
Ra_D_214		7.71E-01	3.88E-02	3.78E-02	7.76E-02	pCi/g	JRO	09/06/14 1247	7630
K-40		1.48E+01	9.48E-01	2.29E-01	4.79E-01	pCi/g	JRO	09/06/14 1247	7630

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**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St. Bldg. 840  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140006  
Lab Sample ID: S1408005-06A  
Matrix: Soil  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client  
Report Date: 9/10/2014 10:30:43 AM  
Client ID: 0206OC

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G,N	6.42E-02	3.09E-02	2.49E-02	5.06E-02	pCi/g	JRO	09/06/14 1848	7630
TL-208	G,N	3.40E-01	3.44E-02	2.07E-02	4.28E-02	pCi/g	JRO	09/06/14 1848	7630
TH-234	G,N	2.53E+00	2.89E+00	1.10E+00	2.24E+00	pCi/g	JRO	09/06/14 1848	7630
TH-228	G,N	2.06E+00	1.33E+00	1.16E+00	2.37E+00	pCi/g	JRO	09/06/14 1848	7630
PB-212	G,N	1.17E+00	5.86E-02	3.15E-02	6.44E-02	pCi/g	JRO	09/06/14 1848	7630
BI-212	G,N	1.21E+00	3.33E-01	2.28E-01	4.76E-01	pCi/g	JRO	09/06/14 1848	7630
AC-228	G,N	1.01E+00	7.83E-02	8.26E-02	1.72E-01	pCi/g	JRO	09/06/14 1848	7630
RA-224		1.06E+00	2.99E-01	3.01E-01	6.17E-01	pCi/g	JRO	09/06/14 1848	7630
Ra_D_214		8.24E-01	4.12E-02	4.12E-02	8.49E-02	pCi/g	JRO	09/06/14 1848	7630
K-40		1.69E+01	1.05E+00	2.14E-01	4.50E-01	pCi/g	JRO	09/06/14 1848	7630

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**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140007  
Lab Sample ID: S1408005-07A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
TL-208	G,N	1.79E-01	2.60E-02	1.93E-02	3.97E-02	pCi/g	JRO	09/07/14 049	7630
TH-232	G,N	1.96E+01	1.11E+01	8.86E+00	1.80E+01	pCi/g	JRO	09/07/14 049	7630
TH-228	G,N	1.07E+00	6.86E-01	9.63E-01	1.96E+00	pCi/g	JRO	09/07/14 049	7630
PB-212	G,N	7.70E-01	4.41E-02	2.32E-02	4.77E-02	pCi/g	JRO	09/07/14 049	7630
BI-212	G,N	8.38E-01	2.68E-01	2.03E-01	4.24E-01	pCi/g	JRO	09/07/14 049	7630
AC-228	G,N	7.05E-01	7.12E-02	6.72E-02	1.40E-01	pCi/g	JRO	09/07/14 049	7630
RA-224		6.25E-01	2.50E-01	2.39E-01	4.90E-01	pCi/g	JRO	09/07/14 049	7630
Ra_D_214		6.76E-01	3.68E-02	3.22E-02	6.65E-02	pCi/g	JRO	09/07/14 049	7630
K-40		1.49E+01	9.20E-01	2.02E-01	4.23E-01	pCi/g	JRO	09/07/14 049	7630

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**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St. Bldg. 840  
WRIGHT-PATTERSON AFB OH, 45433  
Report Date: 9/10/2014 10:30:43 AM  
Contact: SSgt Michael Ames  
Client Sample ID: GS140008  
Lab Sample ID: S1408005-08A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G, N	1.09E-01	3.85E-02	3.08E-02	6.25E-02	pCi/g	TDR	09/05/14 1453	7631
TL-208	G, N	2.63E-01	3.18E-02	2.00E-02	4.13E-02	pCi/g	TDR	09/05/14 1453	7631
TH-234	G, N	2.89E+00	1.98E+00	1.05E+00	2.13E+00	pCi/g	TDR	09/05/14 1453	7631
TH-228	G, N	9.80E-01	9.82E-01	1.25E+00	2.55E+00	pCi/g	TDR	09/05/14 1453	7631
PB-212	G, N	1.03E+00	5.83E-02	3.25E-02	6.64E-02	pCi/g	TDR	09/05/14 1453	7631
PA-234M	G, N	5.77E+00	6.11E+00	4.77E+00	1.01E+01	pCi/g	TDR	09/05/14 1453	7631
BI-212	G, N	9.69E-01	3.45E-01	2.61E-01	5.42E-01	pCi/g	TDR	09/05/14 1453	7631
AC-228	G, N	9.59E-01	9.62E-02	7.40E-02	1.54E-01	pCi/g	TDR	09/05/14 1453	7631
RA-224		1.03E+00	3.01E-01	3.12E-01	6.39E-01	pCi/g	TDR	09/05/14 1453	7631
Ra_D_214		7.12E-01	4.40E-02	3.13E-02	6.52E-02	pCi/g	TDR	09/05/14 1453	7631
K-40		1.41E+01	9.48E-01	2.46E-01	5.15E-01	pCi/g	TDR	09/05/14 1453	7631

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2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140009  
Lab Sample ID: S1408005-09A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G,N	7.29E-02	3.05E-02	2.47E-02	5.01E-02	pCi/g	TDR	09/05/14 2055	7631
TL-208	G,N	2.44E-01	2.65E-02	1.64E-02	3.39E-02	pCi/g	TDR	09/05/14 2055	7631
TH-234	G,N	9.71E-01	7.32E-01	9.27E-01	1.88E+00	pCi/g	TDR	09/05/14 2055	7631
TH-228	G,N	8.23E-01	6.86E-01	1.03E+00	2.10E+00	pCi/g	TDR	09/05/14 2055	7631
PB-212	G,N	8.76E-01	4.84E-02	2.83E-02	5.77E-02	pCi/g	TDR	09/05/14 2055	7631
BI-212	G,N	9.65E-01	2.40E-01	1.67E-01	3.50E-01	pCi/g	TDR	09/05/14 2055	7631
AC-228	G,N	7.64E-01	7.29E-02	6.59E-02	1.37E-01	pCi/g	TDR	09/05/14 2055	7631
RA-224		7.52E-01	2.54E-01	2.58E-01	5.28E-01	pCi/g	TDR	09/05/14 2055	7631
Ra_D_214		7.18E-01	3.50E-02	3.43E-02	7.06E-02	pCi/g	TDR	09/05/14 2055	7631
K-40		1.43E+01	8.81E-01	1.72E-01	3.63E-01	pCi/g	TDR	09/05/14 2055	7631

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**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140010  
Lab Sample ID: S1408005-10A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
TL-208	G,N	2.34E-01	2.81E-02	1.84E-02	3.79E-02	pCi/g	TDR	09/06/14 256	7631
TH-234	G,N	1.69E+00	7.12E-01	8.87E-01	1.80E+00	pCi/g	TDR	09/06/14 256	7631
TH-228	G,N	9.46E-01	6.89E-01	1.04E+00	2.11E+00	pCi/g	TDR	09/06/14 256	7631
PB-212	G,N	8.22E-01	4.73E-02	2.88E-02	5.87E-02	pCi/g	TDR	09/06/14 256	7631
PA-234M	G,N	4.37E+00	4.83E+00	3.77E+00	8.05E+00	pCi/g	TDR	09/06/14 256	7631
BI-212	G,N	9.22E-01	2.89E-01	2.16E-01	4.48E-01	pCi/g	TDR	09/06/14 256	7631
AC-228	G,N	8.28E-01	6.85E-02	6.15E-02	1.28E-01	pCi/g	TDR	09/06/14 256	7631
CD-109	F,N	5.21E-01	3.22E-01	3.64E-01	7.40E-01	pCi/g	TDR	09/06/14 256	7631
RA-224		5.60E-01	2.42E-01	2.61E-01	5.35E-01	pCi/g	TDR	09/06/14 256	7631
Ra_D_214		5.78E-01	3.60E-02	4.26E-02	8.70E-02	pCi/g	TDR	09/06/14 256	7631
K-40		1.69E+01	1.00E+00	2.00E-01	4.18E-01	pCi/g	TDR	09/06/14 256	7631

BRIAN J STROH, Capt, USAF  
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Technical Director, Radioanalytical Laboratory



**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St. Bldg 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140011  
Lab Sample ID: S1408005-11A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G,N	1.59E-01	7.71E-02	6.58E-02	1.32E-01	pCi/g	TDR	09/06/14 858	7631
TL-208	G,N	3.51E-01	3.37E-02	1.93E-02	3.99E-02	pCi/g	TDR	09/06/14 858	7631
TH-234	G,N	2.01E+00	1.13E+00	1.09E+00	2.22E+00	pCi/g	TDR	09/06/14 858	7631
TH-228	G,N	3.78E+00	1.01E+00	1.30E+00	2.64E+00	pCi/g	TDR	09/06/14 858	7631
PB-212	G,N	1.19E+00	6.23E-02	3.45E-02	7.02E-02	pCi/g	TDR	09/06/14 858	7631
PB-210	G,N	4.54E+00	2.51E+00	2.01E+00	4.10E+00	pCi/g	TDR	09/06/14 858	7631
BI-212	G,N	1.14E+00	3.60E-01	2.70E-01	5.60E-01	pCi/g	TDR	09/06/14 858	7631
AC-228	G,N	1.11E+00	8.97E-02	7.51E-02	1.56E-01	pCi/g	TDR	09/06/14 858	7631
CO-60	E,N	1.27E-02	1.44E-02	1.09E-02	2.40E-02	pCi/g	TDR	09/06/14 858	7631
BA-133	E,N	7.03E-02	2.81E-02	4.68E-02	9.51E-02	pCi/g	TDR	09/06/14 858	7631
RA-224		8.41E-01	3.25E-01	3.23E-01	6.61E-01	pCi/g	TDR	09/06/14 858	7631
Ra_D_214		1.07E+00	5.17E-02	3.76E-02	7.77E-02	pCi/g	TDR	09/06/14 858	7631
K-40		1.81E+01	1.10E+00	2.24E-01	4.70E-01	pCi/g	TDR	09/06/14 858	7631

BRIAN J STROH, Capt, USAF  
Chief, Radioanalytical Laboratory

AURELIE M SOREFAN, DR-II, PhD, DAF  
Technical Director, Radioanalytical Laboratory



**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St. Bldg. 840  
Report Date: 9/10/2014 10:30:43 AM  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140012  
Lab Sample ID: S1408005-12A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
TL-208	G,N	3.06E-01	3.17E-02	1.86E-02	3.84E-02	pCi/g	TDR	09/06/14 1459	7631
TH-234	G,N	2.56E+00	8.59E-01	1.07E+00	2.18E+00	pCi/g	TDR	09/06/14 1459	7631
TH-228	G,N	2.30E+00	8.43E-01	1.08E+00	2.20E+00	pCi/g	TDR	09/06/14 1459	7631
PB-212	G,N	1.20E+00	8.51E-02	3.21E-02	6.55E-02	pCi/g	TDR	09/06/14 1459	7631
BI-212	G,N	8.84E-01	2.62E-01	2.00E-01	4.20E-01	pCi/g	TDR	09/06/14 1459	7631
AC-228	G,N	1.09E+00	8.22E-02	6.10E-02	1.28E-01	pCi/g	TDR	09/06/14 1459	7631
I-131	E,N	2.71E-01	3.12E-01	2.49E-01	5.23E-01	pCi/g	TDR	09/06/14 1459	7631
CD-109	E,N	4.62E-01	3.52E-01	4.37E-01	8.87E-01	pCi/g	TDR	09/06/14 1459	7631
RA-224		7.30E-01	3.55E-01	3.03E-01	6.20E-01	pCi/g	TDR	09/06/14 1459	7631
Ra_D_214		7.64E-01	4.30E-02	3.48E-02	7.20E-02	pCi/g	TDR	09/06/14 1459	7631
K-40		1.63E+01	1.02E+00	2.43E-01	5.08E-01	pCi/g	TDR	09/06/14 1459	7631

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**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St Bldg 840  
WRIGHT-PATTERSON AFB OH, 45433  
Contact: SSgt Michael Ames  
Client Sample ID: GS140013  
Lab Sample ID: S1408005-13A  
Matrix: Soil  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client  
Report Date: 9/10/2014 10:30:43 AM  
Client ID: 0206OC

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G,N	7.21E-02	2.86E-02	2.31E-02	4.70E-02	pCi/g	TDR	09/06/14 2100	7631
TL-208	G,N	2.69E-01	2.77E-02	1.73E-02	3.57E-02	pCi/g	TDR	09/06/14 2100	7631
TH-228	G,N	1.48E+00	7.01E-01	1.17E+00	2.37E+00	pCi/g	TDR	09/06/14 2100	7631
PB-212	G,N	9.75E-01	1.01E-01	2.92E-02	5.95E-02	pCi/g	TDR	09/06/14 2100	7631
BI-212	G,N	1.19E+00	2.99E-01	2.05E-01	4.27E-01	pCi/g	TDR	09/06/14 2100	7631
AC-228	G,N	8.15E-01	7.26E-02	5.62E-02	1.17E-01	pCi/g	TDR	09/06/14 2100	7631
RA-224		8.24E-01	3.23E-01	2.59E-01	5.30E-01	pCi/g	TDR	09/06/14 2100	7631
Ra_D_214		7.49E-01	3.53E-02	3.02E-02	6.23E-02	pCi/g	TDR	09/06/14 2100	7631
K-40		1.79E+01	1.03E+00	1.93E-01	4.05E-01	pCi/g	TDR	09/06/14 2100	7631

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AURELIE M SOREFAN, DR-II, PhD, DAF  
Technical Director, Radioanalytical Laboratory



**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Certificate of Analysis**

Company: USAFSAM/OEC  
Address: 2510 Fifth St. Bldg. 040  
WRIGHT-PATTERSON AFB OH, 45433  
Report Date: 9/10/2014 10:30:43 AM  
Contact: SSgt Michael Ames  
Client Sample ID: GS140014  
Lab Sample ID: S1408005-14A  
Matrix: Soil  
Client ID: 0206OC  
Collection Date: 7/30/2014  
Receive Date: 8/5/2014  
Collector: Client

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
<b>Gamma Spec Full</b>									
U-235	G, N	6.63E-02	3.10E-02	2.50E-02	5.07E-02	pCi/g	TDR	09/07/14 302	7631
TL-208	G, N	2.58E-01	3.01E-02	1.87E-02	3.87E-02	pCi/g	TDR	09/07/14 302	7631
TH-234	G, N	9.72E-01	8.00E-01	1.02E+00	2.08E+00	pCi/g	TDR	09/07/14 302	7631
PB-212	G, N	9.66E-01	8.97E-02	3.10E-02	6.33E-02	pCi/g	TDR	09/07/14 302	7631
BI-212	G, N	8.84E-01	2.40E-01	1.74E-01	3.66E-01	pCi/g	TDR	09/07/14 302	7631
AC-228	G, N	8.28E-01	7.97E-02	6.93E-02	1.44E-01	pCi/g	TDR	09/07/14 302	7631
CS-137	D, F, N	3.69E-02	2.00E-02	1.53E-02	3.19E-02	pCi/g	TDR	09/07/14 302	7631
RA-224		6.22E-01	3.48E-01	2.82E-01	5.78E-01	pCi/g	TDR	09/07/14 302	7631
Ra_D_214		7.59E-01	4.34E-02	3.59E-02	7.40E-02	pCi/g	TDR	09/07/14 302	7631
K-40		1.46E+01	9.24E-01	2.07E-01	4.36E-01	pCi/g	TDR	09/07/14 302	7631

BRIAN J STROH, Capt, USAF  
Chief, Radioanalytical Laboratory

AURELIE M SOREFAN, DR-II, PhD, DAF  
Technical Director, Radioanalytical Laboratory





**Radioanalytical Services Laboratory**  
2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

**Radiation Qualifier List**

Qualifier	Qualifier Description
A	Identification Rejected
B	(ELAP) Blank Contamination
C	Inconclusive
D	Misidentification
E	False Positive
F	Consistent with False Positive
G	Qualitatively consistent with detector background
H	Quantitatively consistent with detector background
I	Inconsistent energy shift
J	(ELAP) The reported results is an estimated value
N	(ELAP) Non-target analyte
Q	(ELAP) One or more quality control criteria failed
U	(ELAP) Analyte was not detected and is reported as less than the LOD
K	Inconsistent Full Width Half Max (FWHM)
L	Hold time exceeded
M	Results invalid

**Attachment 2**  
**Map of Gamma Walkover with Soil Sample Locations**

# McClellan CS 022 Verification Survey

Gamma Walkover with Soil Sampling Locations



## Legend

- < -2.5 Std. Dev.
- -2.5 - -1.5 Std. Dev.
- -1.5 - -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- 1.5 - 2.5 Std. Dev.
- > 2.5 Std. Dev.

✕ Soil Samples

□ CS-22 Disposal Pit Outline

0 5 10 20 30 40 Meters



Author: SSgt Michael Ames

**Attachment 3**  
**Instrument Calibration Sheets**

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OCCUPATIONAL ENVIRONMENTAL HEALTH  
WRIGHT-PATTERSON AFB OHIO  
CERTIFICATE OF CALIBRATION**

Mfg. Ludlum Model 2221 Serial # 287511 Index # 102209 Date: 16-Jun-14  
Mfg. Scionix Model 768RS763M-E1-X Serial # SAG 420 Index # N/A Cal. Due Date: 16-Jun-15

**TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT**

NIST Traceable Check Sources				Reference Instruments			
Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs 137	MU851	01-Nov-04	1974084	Ludlum	500-1	102952	4 DEC 2014

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☒ Battery Ck. ☒ Mechanical Ck. ☒ Meter Zeroed ☒ Reset Ck. ☐ Alarm Ck.  
☒ Audio Ck. ☒ Geotropism Ck. ☒ F/S Resp. Ck. ☒ Window Op.

As Found HV 494 VDC Temperature 70.1 °F Relative Humidity 62.4 %

Final Volt. Set 700 VDC Threshold (LLD) 9 mV Window (ULD) 20 mV Window width 11 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V  
Inst. Readout: 497 V  $\pm 2\%$  Inst. Readout: 1.012 V  $\pm 2\%$

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	380,000 CPM	400,000 CPM
x 1000	100 CPM	110,000 CPM	110,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	11,000 CPM	11,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,100 CPM	1,100 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	110 CPM	110 CPM
Log Scale	200 CPM	200 CPM	200 CPM

**DIGITAL SCALER READOUT**

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	40,000 CPM	40,000 CPM

\*UNCERTAINTY WITHIN  $\pm 10\%$  CORRECTION FACTOR WITHIN  $\pm 20\%$

COMMENTS: Calibration interval = 1 year Use "Window OUT"

Detector Parameters: Page2- 3

**Procedural Authority - ICP#22210000**

Calibrated By: Kurt Shuts

Date: 16-Jun-2014

Reviewed By: Maurice Fatima

Date: 17 June 2014

Page 1

pg 3 of 3

Jun 16 2014 03 13 PM Kurt Shorts  
HotSpot FIDLER Calibration Information

Report Date : Jun 16 2014 03:13 PM  
Calibration Date : 16 June 2014  
Target Mix : Other Nuclide Check Source  
Radionuclide : Cs-137  
Detector Barcode Number : N/A  
Meter Barcode Number : 102209  
Detector Manufacturer : Scionix  
Detector Model Number : 76BRS76/3M-E1-X  
Detector Serial Number : SAG420  
Meter Manufacturer : Ludlum  
Meter Model Number : 2221  
Meter Serial Number : 287511

Check Source I.D. : RP 3067  
Calibration Date : 16 June 2014  
Calibrated by : Kurt Shorts  
Check Source Activity (uCi): 8.890E-01

Sample Counting Time (minutes) : 1.000E+00  
Detector Height (cm) : 3.000E+01

Cs-137 window Information:

Background (cpm) : 9,928  
Areal Limit of Sensitivity (uCi/m2) : 6.9E-02  
Point Limit of Sensitivity (uCi) : 6.4E-02  
K-factor (m2) : 0.92

Counting Data (counts):

0-cm: 16455  
20-cm: 14967  
40-cm: 12820  
60-cm: 11625  
80-cm: 11051  
100-cm: 10321

Instrument Type :Other

Window Option:Only 60 keV

Units:Classic

This is an actual 3x3 calibration, and the values are typical of most 3x3 configurations.

Detector Calibration Results

Cs-137 window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)): 6.8E+03  
Cs-137 Detector Areal LOS (uCi/m2) : 6.9E-02  
Cs-137 Detector Point LOS (uCi) : 6.4E-02  
Cs-137 Detector Background Rate (cpm) : 9,928  
Cs-137 Detector Check Source Rate (cpm) : 6,527  
Cs-137 Detector K-Factor (m2) : 0.92  
Cs-137 Detector K-Factor sdev (%) : 5.3



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CERTIFICATE OF CALIBRATION**

Mfg. Ludlum Model 2221 Serial # 287537 Index # 102210 Date: 24-Jun-14  
Mfg. Scionix Model 76BR576/2ME1-X Serial # SAG 423 Index # 08335 Cal. Due Date: 24-Jun-15

**TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT**

NIST Traceable Check Sources				Reference Instruments			
Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs 137	RP3067	01-Nov-04	1972997	Ludlum	500-1	102931	06 MAR 2015

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☒ Battery Ck. ☒ Mechanical Ck. ☒ Meter Zeroed ☒ Reset Ck. ☐ Alarm Ck.  
☒ Audio Ck. ☒ Geotropism Ck. ☒ F/S Resp. Ck. ☒ Window Op.

As Found HV 647 VDC Temperature 88.0 °F Relative Humidity 63.8 %

Final Volt. Set 675 VDC Threshold (LLD) 10 mV Window (ULD) 19 mV Window width 9 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V  
Inst. Readout: 500 V  $\pm$  2% Inst. Readout: 1,006 V  $\pm$  2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	400,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	200 CPM	200 CPM

**DIGITAL SCALER READOUT**

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	40,067 CPM	40,067 CPM

\*UNCERTAINTY WITHIN  $\pm$  10% CORRECTION FACTOR WITHIN  $\pm$  20%

COMMENTS: Calibration Interval = 1 year Use "Window OUT"

Detector Parameters: Page2- 3

Procedural Authority - ICP#22210000

Calibrated By: [Signature]

Date: 24-Jun-2014

Reviewed By: [Signature]

Date: 25-Jun-2014



Mfg. <u>Ludlum</u>	Model <u>2221</u>	Serial # <u>267537</u>	Index # <u>102210</u>	Date: <u>24-Jun-14</u>
Mfg. <u>Scionix</u>	Model <u>78BR5762ME1-K</u>	Serial # <u>SAG 423</u>	Index # <u>08335</u>	Cal. Due Date: <u>24-Jun-15</u>

Mfg.	Model	Serial #	Cal. Due Date
Ludium	500-1	102951	06 MAR 2015

Probe #3  
Mfg. \_\_\_\_\_ N/A  
Model \_\_\_\_\_  
Serial # \_\_\_\_\_  
Index # \_\_\_\_\_  
Isotope: \_\_\_\_\_

[illegible]

Efficiency                      CPM/ $\mu\text{Ci}/\text{m}^2$  @12"

Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW-2015-1640, 31 Mar 2015



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Jun 24 2014 01 40 PM Willis Hosley  
HotSpot FIDLER Calibration Information

Report Date : Jun 24 2014 01:40 PM  
Calibration Date : June 24 2014  
Target Mix : Other Nuclide Check Source  
Radionuclide : Cs-137  
Detector Barcode Number : 08335  
Meter Barcode Number : 102210  
Detector Manufacturer : Scionix  
Detector Model Number : 76BRS76/3M-E1-X  
Detector Serial Number : SAG423  
Meter Manufacturer : Ludlum  
Meter Model Number : 2221  
Meter Serial Number : 287537

Check Source I.D. : RP 3067  
Calibration Date : June 24 2014  
Calibrated by : Willis Hosley  
Check Source Activity (uCi): 8.890E-01

Sample Counting Time (minutes) : 1.000E+00  
Detector Height (cm) : 3.000E+01

Cs-137 window Information:

Background (cpm) : 9,258  
Areal Limit of Sensitivity (uCi/m2) : 1.1E-02  
Point Limit of Sensitivity (uCi) : 5.5E-02  
K-factor (m2) : 4.83

Counting Data (counts):

0-cm: 16549  
20-cm: 14818  
40-cm: 12314  
60-cm: 11101  
80-cm: 10529  
100-cm: 10378

Instrument Type : Other

Window Option: Only 60 keV

Units: Classic

This is an actual 3x3 calibration, and the values are typical of most 3x3 configurations.

Detector Calibration Results

Cs-137 window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)): 4.0E+04  
Cs-137 Detector Areal LOS (uCi/m2) : 1.1E-02  
Cs-137 Detector Point LOS (uCi) : 5.5E-02  
Cs-137 Detector Background Rate (cpm) : 9,258  
Cs-137 Detector Check Source Rate (cpm) : 7,291  
Cs-137 Detector K-Factor (m2) : 4.83  
Cs-137 Detector K-Factor sdev (%) : 5.2

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CERTIFICATE OF CALIBRATION**

Mfg. Ludlum Model 2221 Serial # 290803 Index # 102204 Date: 03-Jun-14  
Mfg. Scionix Model 718R5753M-E1-K Serial # SAG 427 Index # N/A Cal. Due Date: 03-Jun-15

**TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT**

NIST Traceable Check Sources				Reference Instruments			
Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs 137	MU851	01-Nov-04	1975850	Ludlum	500-1	102952	4 DEC 2014

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☒ Battery Ck. ☒ Mechanical Ck. ☒ Meter Zeroed ☒ Reset Ck. ☐ Alarm Ck.  
☒ Audio Ck. ☒ Geotripism Ck. ☒ F/S Resp. Ck. ☒ Window Op.

As Found HV 694 VDC Temperature 64.8 °F Relative Humidity 69.7 %

Final Volt. Set 675 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V  
Inst. Readout: 497 V  $\pm$  2% Inst. Readout: 1,010 V  $\pm$  2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	420,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	200 CPM	200 CPM

**DIGITAL SCALER READOUT**

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	40,304 CPM	40,304 CPM

\*UNCERTAINTY WITHIN  $\pm$  10% CORRECTION FACTOR WITHIN  $\pm$  20%

COMMENTS: Calibration Interval = 1 year Use "Window OUT"

Detector Parameters: Page 2- 3

**Procedural Authority - ICP#22210000**

Calibrated By: Kurt Shotts

Date: 03-Jun-2014

Reviewed By: Mauricio Latorre

Date: 3 Jun '14



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CERTIFICATE OF CALIBRATION**

Mfg. Ludlum Model 2221 Serial # 290803 Index # 102204 Date: 03-Jun-14  
Mfg. Scionix Model 76BS76/3M-E1-X Serial # SAG 427 Index # N/A Cal. Due Date: 03-Jun-15

**TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT**

NIST Traceable Check Sources				Reference Instruments			
Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs 137	MU851	01-Nov-04	1975850	Ludlum	500-1	102952	4 DEC 2014

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

**NaI DETECTOR HIGH VOLTAGE OPTIMIZATION**

Probe #1  
Mfg. Scionix  
Model 76BS76/3M-E1-X  
Serial # SAG 427  
Index # N/A  
Isotope: Cs-137 @ 6"

Probe #2  
Mfg. N/A  
Model \_\_\_\_\_  
Serial # \_\_\_\_\_  
Index # \_\_\_\_\_  
Isotope: \_\_\_\_\_

Probe #3  
Mfg. N/A  
Model \_\_\_\_\_  
Serial # \_\_\_\_\_  
Index # \_\_\_\_\_  
Isotope: \_\_\_\_\_

High Voltage	CPM
500	26601
550	27564
600	27895
650	27826
*675	27780
700	28274
750	28287
800	28173
850	30217
900	41729
-----	-----
-----	-----
-----	-----
Bkgd @ 675v	8,781

High Voltage	CPM

High Voltage	CPM

Final Volt. Set 675 VDC      Final Volt. Set \_\_\_\_\_ VDC      Final Volt. Set \_\_\_\_\_ VDC  
Efficiency 9900 CPM/μCi/m<sup>2</sup> @ 12"      Efficiency \_\_\_\_\_ CPM/μCi/m<sup>2</sup> @ 12"      Efficiency \_\_\_\_\_ CPM/μCi/m<sup>2</sup> @ 12"

COMMENTS: Calibration Interval = 1 year      Use "Window OUT"  
  
**Procedural Authority - ICP#22210000**

Calibrated By: Rod-Shorts  
Reviewed By: Manufacturing

Date: 03-Jun-2014  
Date: 3 Jun '14

Jun 03 2014 11 07 AM Kurt Shorts  
HotSpot FIDLER Calibration Information

Report Date : Jun 03 2014 11:07 AM  
Calibration Date : 03 June 2014  
Target Mix : Other Nuclide Check Source  
Radionuclide : Cs-137  
Detector Barcode Number : N/A  
Meter Barcode Number : 102204  
Detector Manufacturer : Scionix  
Detector Model Number : 76BRS76/3M-E1-X  
Detector Serial Number : SAG427  
Meter Manufacturer : Ludlum  
Meter Model Number : 2221  
Meter Serial Number : 290803

Check Source I.D. : RP 3067  
Calibration Date : 03 June 2014  
Calibrated by : Kurt Shorts  
Check Source Activity (uCi): 8.900E-01

Sample Counting Time (minutes) : 1.000E+00  
Detector Height (cm) : 3.000E+01

Cs-137 window Information:

Background (cpm) : 8,781  
Areal Limit of Sensitivity (uCi/m2) : 4.4E-02  
Point Limit of Sensitivity (uCi) : 5.5E-02  
K-factor (m2) : 1.24

Counting Data (counts):

0-cm: 15887  
20-cm: 13996  
40-cm: 12147  
60-cm: 10389  
80-cm: 10225  
100-cm: 9606

Instrument Type :Other  
Window Option:Only 60 kev

Units:Classic

This is an actual 3x3 calibration, and the values are typical of most 3x3 configurations.

Detector Calibration Results

Cs-137 window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)): 9.9E+03  
Cs-137 Detector Areal LOS (uCi/m2) : 4.4E-02  
Cs-137 Detector Point LOS (uCi) : 5.5E-02  
Cs-137 Detector Background Rate (cpm) : 8,781  
Cs-137 Detector Check Source Rate (cpm) : 7,106  
Cs-137 Detector K-Factor (m2) : 1.24  
Cs-137 Detector K-Factor sdev (%) : 5.3

**Attachment 4**  
**Radiation Meter Quality Control (QC) Log**

[illegible]

## Attachment 5

### Statistical Summary of Instrument Data

Instrument Model Number: Ludlum 2221 / Scionix 76BRS76 3x3 NaI

Instrument Serial Number: 287511 / SAG420

Surface Type: Dirt/Soil

